Prince George Forest Region

Forest Resources & Practices Team

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FOREST RESEARCH NOTE

The influence of planting density on the early performance of three sub-boreal tree species in the Prince George Forest Region

EXPERIMENTAL PROJECT 660 - Overview of three experimental installations – A 30-year Progress Report

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Experimental Project 660 (EP 660) was established in 1967 to evaluate and compare the performance of plantations of white spruce, lodgepole pine and Douglas-fir at various espacements on three different plantations within the Prince George Forest Region. This report provides an overview of the history, rationale and methodology of the study.

Details on the results of the 30-year growth performance of the three individual study locations are reported in separate Research Note publications within this series: Research Note PG 12-1 for the Buckhorn Ridge Installation, PG 12-2 for the Bobtail Road Installation, and PG 12-3 for the Chilco Creek Installation.

Forward

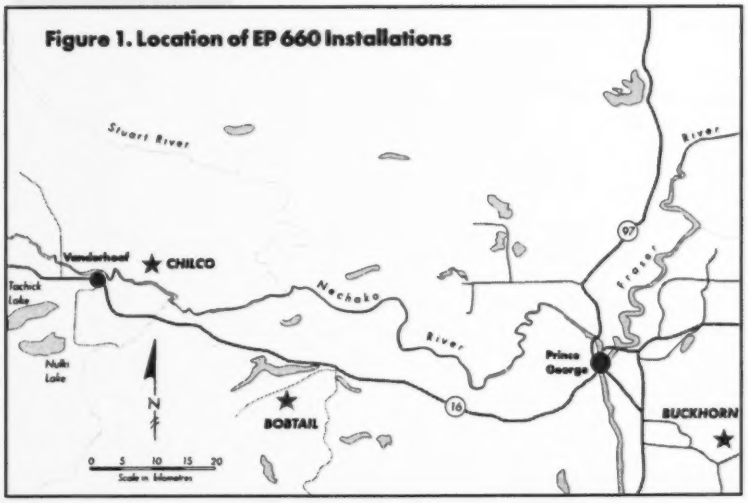
The long periods of time required to grow a stand of trees from initial planting to final harvest is a unique aspect to the practice of forestry. Periods of time of five to ten years which may encompass the entire lifetime of a scientific study in other disciplines mean little to long-term studies on plantation growth and yield.

The EP 660 project provides some unique insights into the growth patterns and the interactions occurring within a forest plantation over 30 years. To our knowledge, this is one of the very few studies of its kind in the Prince George area that has been continually monitored over such a period of time.

In reading through the project reports, we often overlook the history surrounding projects of this nature and the commitment of the researchers who pushed to install and maintain these study plots.

The first research plantations on the Buckhorn Ridge were installed by T. Decie in 1957, then Forester-in-Charge at the Aleza Lake Experimental Station northeast of Prince George. The original white spruce and Douglas-fir stands were logged in 1954/55. Parts of the present research area were burned in the small Buck fire of 1957. In 1958, the first spruce espacement trial in the central interior of the province was established on the site (EP 549). This plantation was subsequently wiped out by the huge Grove fire in August 1961. The trial was reestablished as the EP 660 near the original site in the summer of 1967. In 1965 John Revel and Harry Coates re-established the spruce espacement trials on the Buckhorn site. A new study, designated EP 660, was established in 1967 at the Buckhorn site following the design criteria of EP 549. Two additional installations were added to the EP 660 project; a second installation at Cluculz Lake on the Bobtail Forest Road east of Prince George, and a third installation near Chilco Creek northeast of Vanderhoof.

Figure 1. Location of EP 660 Installations



Introduction

Despite the huge size of the Prince George Forest Region, planting stock for reforestation work is drawn from a relatively small number of species. Only two species of conifer are planted in significant number in the Prince George region. Lodgepole pine (*Pinus contorta*) and Engelmann and white spruce (*Picea engelmannii* x *Picea glauca*) account for more than 97.5 percent of all the trees planted within the region (BC Ministry of Forests, 1995). Douglas-fir (*Pseudotsuga menziesii*) makes up less than three percent of the total planting program. It has been shown to have been a poor early plantation performer in artificially regenerated stands.

In northern BC, selecting the appropriate tree species and stocking level to ensure optimum growth and yield is still the most important silvicultural decision affecting the yield of managed stands. Species selection and the initial espacement of planted trees has a significant effect on the growth and yield of the stands, on wood quality, and on planting and stand management costs (Bella and DeFrancheschi 1974).

Unfortunately, there is very little data available on the long-term growth and yield of various species, planted at a variety of stand densities, and on sites of different quality in the central interior of BC. More knowledge is needed to assist foresters and silviculturalists is managing these stands for optimum productivity. For example, there is little information on which to base estimates of volume losses to various disease and animal pests. Future stocking standards pertaining to species selection must reflect the probability of such losses over the entire rotation of the stand, not simply to the end of the free growing period.

Study Objectives

There are three primary objectives for EP 660:

1. To establish pure, replicated plantings of Douglas-fir, lodgepole pine, and white spruce at 2 metre x 2 metre, 3 metre x 3 metre and 4 metre x 4 metre espacements.
2. To monitor these plots with periodic evaluations of survival, incidence of damage and disease, and growth and yield for each species-espacement combination.
3. To maintain each installation of the project as a long-term demonstration and teaching area.

Study Areas

The three study locations within the Prince George forest region were chosen for this experimental project because they represented a range of soil conditions with similar logging histories.

The Buckhorn Ridge Site

The Buckhorn Ridge research site is located approximately 45 kilometres southeast of Prince George along the Buckhorn Forest Service Road. The site lies within the sub-mesic to mesic association of the Fraser Basin variant of the Moist Cool Central sub-zone of the Sub-Boreal spruce biogeoclimatic zone ($SBS_{mk1/05}$, formerly the $SBS_{c2/05}$, DeLong and Tanner 1996). Mean elevation of the study area is approximately 900 metres.

The Buckhorn area is underlain by Brunisolic Gray Luvisols developed from medium to moderately-fine textured, gravelly glacial till parent material (Dawson 1989). This area, along with much of the Fraser River basin, has a root-restricting compacted Bt horizon at approximately 30 centimetres depth in the soil profile. Frequent fires in the Buckhorn area have removed much of the organic layer more typically found under mature forest stands in and around Prince George. A very thin, poorly developed Mor forest floor is present under most of the juvenile stands on this site.

The Bobtail Road Site

The Bobtail study site is located approximately 60 kilometres southwest of Prince George, at kilometre 21 along the Bobtail Lake Forest Service Road. The site is located within the sub-mesic to mesic wild sarsaparilla - princes pine - sitka alder association of the Nechako River variant of the Dry Warm Southern sub-zone of the sub-boreal spruce biogeoclimatic zone (the $SBS_{dw3/04.1}$, formerly the $SBS_{k3/04.1}$, DeLong , Tanner and Jull 1993). Mean elevation of the study area is approximately 840 metres.

The soils of this area are Brunisolic Gray Luvisols belonging to the Deserters series (Dawson1989). These soils are developed from gravely and stony glacial till deposits and tend to be medium to moderately fine textured gravely loams to gravely clay loams.

The original stands of white spruce were clear-cut logged in the winter of 1964-65, and the cut blocks were broadcast burned in 1965.

The Chilco Creek Site

The Chilco Creek study area is located approximately 65 kilometres northwest of Prince George and 20 kilometres east of Vanderhoof along the River Road. Like the Cluculz Lake study site, the Chilco Creek installation is also located within the SBS_{dw3}. However, the Chilco site is moister than the Bobtail installation and is located in the mesic to sub-hygic black twinberry - colt's foot association ($SBS_{dw3/06}$, formerly the $SBS_{k3/06}$, DeLong , Tanner and Jull 1993). The mean elevation is approximately 760 metres. The original stands of white spruce were clear-cut logged in 1965/66, and the site was broadcast burned in 1966.

The soils of the Chilco Creek area are Orthic Gray Luvisols from the Pineview and Vanderhoof soil series (Dawson1989). These soils have developed from clayey glacial lake deposits over glacial till and tend to be very fine textured clays and silty clays.

Materials And Methods

Planting Stock

Seedlings utilized in the species-espacement trial were grown from local provenances of lodgepole pine, Douglas-fir, and white spruce seed. The seedlings were either 1+1 (lodgepole pine and Douglas-fir) or 2+1 (white spruce) bare-root transplants. The 2+1 white spruce stock was utilized to approximate the size and

shoot-to-root ratio of the larger 1+1 lodgepole pine and Douglas-fir seedlings.

Plot Layout

Initial planting at the three sites was carried out in May of 1967. First year mortality was replaced in April of the following year. Lower than expected first year mortality resulted in surplus planting stock, which was subsequently utilized for a fourth espacement of each species in the southwestern corner of the Buckhorn Ridge site only. These additional plots, planted at 1.5m x 1.5m espacement, were installed in the spring of 1968. This treatment was not replicated at any of the other installations.

Experimental plots were planted as either 11 x 11 tree plots (for the 3m x 3m and 4m x 4m espacements), 14 x 14 tree plots (for the 2m x 2m espacements) or 18 x 18 tree plots (for the 1.5m x 1.5m escapements). Evaluation on each of the replicate plots was limited to the center 49 trees, however, to reduce the effect of plot edges on measured variables.

Plot Maintenance and Stand Measurement

The plot boundaries, trail flagging, plot identity tags and tree number tags that were established in 1967, have been maintained as required. However, there was no concerted effort to brush and weed the installations until 1979. Complete brushing and weeding of plots and boundaries took place in 1979, 1983, 1986 and 1996 at the Buckhorn and Bobtail sites, and in 1976, 1986 and 1997 at the Chilco site.

Since its establishment in 1967, the three study area plots of EP 660 have been evaluated on five occasions; an eleven year evaluation in 1977, a 15-year evaluation in 1981, a 20-year evaluation in 1986, a 25-year measurement in 1991. The 30-year evaluations, discussed in this Research Note, were completed in the Fall of 1996 and spring of 1997.

During the first measurements in 1977, the trees were not numbered. In 1981, the study trees were tagged, but many of these original tags were lost or destroyed. All trees within the plots were re-tagged in 1986. However, the pattern of live and dead trees within plots dating back to 1977 does allow us to identify individual trees from early measurements. All evaluations and analyses were based on plot means which were unbiased by the inconsistent numbering.

Up to 1991, measurements of tree heights were made to the nearest 5 centimetres using 15 metre telescoping height poles. After 1991, all height measurements were made to the nearest 10 centimetres, using a Criterion laser.

Trees were measured for DBH and estimates made of the height to live crown, greatest crown width and least crown width. The diameter of the lowest live branch was measured and damage to stems, foliage and leaders from small mammals, disease and abiotic factors was noted. Qualitative estimates of the damage severity from each source were based on the extent of the injury (for example, the amount of the stem girdled by a squirrel or hare) and the apparent health of the attacked tree in question.

Experimental Design

Two replicates of each of the species-espacement combinations were laid out in side-by-side rectangular blocks measuring approximately 320 metres by 42 metres. Plot assignments were freshly randomized for each of the two replicates at each site, resulting in a randomized complete block experimental design. The data were analysed utilizing a repeated measures Analysis of Variance (ANOVA) technique.

Results and Discussion

The results for each of the three individual EP 660 trials are reported in accompanying Research Note publications PG 12-1: The Buckhorn Ridge Research Site, PG 12-2: The Bobtail Road Research Site and PG 12-3: The Chilco Creek Research Site.

However, there are some notable observations that are common to all three research installations.

- The lodgepole pine that have survived through the thirty years since the EP 660 trials were established, are still doing well. They are still the tallest and largest diameter trees at all three installations. However, there has been heavy damage from biotic sources (disease, insects and small mammals) during this time. These losses have resulted in poorly stocked stands, and losses to total volume (in these stands).
- Douglas-fir has grown well on all three sites. The Douglas-fir has suffered very little biotic damage. However, this species has been very susceptible to abiotic damage (hail, snow load, frost, etc.).
- White spruce is the tortoise in the race. It has started slowly and after 30 years, is still substantially shorter and smaller in diameter than either lodgepole pine or Douglas-fir. However, the growth rate of this species is now picking up and it also appears to be immune to most biotic and abiotic damage that has so badly impacted the plantations of pine and Douglas-fir.

Conclusions

Douglas-fir is an extremely valuable species that can grow very well on the right sites in the Prince George area. However, it is susceptible to abiotic damage such as frost (in younger plantations), hail and snow break. Tree breeding programs in other regions have tried to produce Douglas-fir trees with low branch angles that will catch smaller amounts of snow, making them less susceptible to breakage. Unfortunately, there appears to be little opportunity to select for greater frost resistance in this species, given that we are so close to the northern limits of its distribution.

Douglas-fir does not commonly occur in pure stands in nature, so some thought should be given to growing it as one species in a mixedwood complex. Such stands probably offer individual Douglas-fir much better protection from abiotic damage than would the single species plantings such as those at the EP 660 installations.

Lodgepole pine shows excellent resistance to most abiotic agents. However a whole host of biotic pest afflict this species. Plantations that start at relatively low total densities may have very few live trees left after one or two outbreaks of cyclical pests such as squirrels or snowshoe hares (Sullivan 1987, 1996, Sullivan et al. 1981, 1987, 1996) or from the losses to endemic pests such as western gall rust (Hendry and Cozens, 1989; Van der Kamp, 1981). Wood quality in future stands grown at low density is also a subject that deserves a great deal of additional study. All the lodgepole pine grown at low density and wide espacements had very large lowest live branch diameters. Large live branches on the first log has been shown to negatively impact both future wood quality and wood recovery rates (Middletown et al. 1995,1996).

Although white spruce has grown much slower than either Douglas-fir or lodgepole pine at the EP 660 installations, many of the spruce stands now contain some very impressive trees. White spruce seems to be less susceptible to many of the pests, pathogens and abiotic damaging events that have plagued both Douglas-fir and lodgepole pine. This species has grown slowly but steadily for the past 30 years, and the species differences in height and diameter between it and the other two species are not as evident now as they were as little as 10 years ago. It may well be that in 30 or 40 years these spruce stands will have the greatest overall wood value.

The data that has been gathered to date presents some useful insights into the early to mid-successional progress of the three species. However, the story of these stands has changed substantially in the last 10 years and will likely change again. It is still too early to make conclusions about the long term outcome for these stands.

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